Water Resources Assessments and Research Subactivity

Program	FY 2000 Estimate	Uncontrol. & Related Changes	Program Changes	FY 2001 Budget Request	Change from FY 2000
Ground-Water Resources	2,800	+87	0	2,887	+87
National Water-Quality Assessment	61,883	+1,263	0	63,146	+1,263
Toxic Substances Hydrology	13,306	+331	-1,240	12,397	-909
Hydrologic Research & Development	**13,048**	**+331**	**[(1)] -1,454**	**11,925**	**-1,123**
Total Requirements $000	91,037	+2,012	-2,694	90,355	-682

[1] See Program Change section for details on Columbia River Aquatic Resources (+$1,000) and programmatic decrease (-$2,454).

Hydrologic Research and Development

Current Program Highlights

The Hydrologic Research and Development Program focuses on long-term investigations that integrate hydrological, geological, chemical, climatic, and biological information related to water resources issues. The program develops new fundamental knowledge about the processes affecting water and develops new methods and interpretive techniques to aid in data collection, understanding, and prediction. Its long-term interdisciplinary approach allows work on large, difficult hydrologic problems, and the direct linkage of the program with other USGS water-resources programs ensures that the research remains relevant to water-resources needs. The USGS scientists supported by this program provide training, workshops, reviews, and advice to USGS staff working on all water programs to enhance their capabilities. Thus, through its research, development, and information transfer, this program provides the foundation for the technologies and conceptual approaches used in all USGS water programs for the future. The new knowledge, tools, and insight needed to solve hydrologic problems are gained through three approaches: Individual Studies, Large Interdisciplinary Studies, and the Development of Tools and Methods.

Small Individual Studies -- Those receiving current emphasis include studies directed towards gaining an understanding of the:

- processes related to the transport of viruses, bacteria, and protozoa in water and their role in ground water remediation,
- shape of river channels and the erosional processes governing the source, mobility, and deposition of sediment,
- microbial and chemical reactions in the zone of a stream bank where recharge or discharge occurs, causing mixing of the stream and ground water,
- movement of water, solutes, and gases through various environments and materials,
- chemical and biochemical reactions affecting natural and contaminated water,
- interaction of ground water and surface water in key areas such as wetlands,

- processes and factors (such as land use) that govern the sources, sinks, and transport of carbon and nitrogen, and
- effect of subsidence on wetland habitat loss and as a threat to low-lying population centers.

A new focus of work in FY 2001 relates to sediment mobilization and carbon sequestration in the Lower Mississippi River Basin, where the loss of riparian forests and wetlands from ground-water withdrawals, subsidence, surface-water flow, and land-use practices is of concern. The amount of sediment mobilized by these phenomena affects the sequestration of carbon in channels, reservoirs, and wetlands. The USGS will investigate the relationships between water and sediment transport and its effect on carbon storage to provide better information for resource managers.

Large Interdisciplinary Studies -- The following are selected examples of research that is conducted primarily through large interdisciplinary studies:

- Hypoxia causes -- Hypoxia, a low oxygen condition in water, is known to be related to high levels of nitrogen and its associated algal blooms. Although scientists believe hypoxia in the Gulf of Mexico is related to nitrogen from the Mississippi River and its tributaries, it is unclear to what extent various sources of nitrogen contribute to the hypoxia problem. A USGS research study is considering geochemistry, microbiology, and transport of nitrogen species and is examining denitrification and its impact on nitrogen transport. Denitrification is a natural reaction that transforms nitrate, a harmful form of nitrogen, into nitrogen gas, which is environmentally benign. Research efforts are currently focused at a NAWQA site with high agricultural input of nitrogen in the Illinois River basin and at a Mississippi River pool near La Crosse, Wisconsin. (Note: the Toxic Substances Hydrology Program also funds some work related to the hypoxia issue, and the National Stream Quality Accounting Network, which is funded by the Hydrologic Networks and Analysis Program, contributes to the hypoxia effort through nutrient monitoring in the Mississippi River.)

- Regional and global biogeochemical cycles (such as the carbon and nitrogen cycles) in rivers, lakes and reservoirs -- Five water, energy, and biogeochemical budgets (WEBB) sites in Colorado, Wisconsin, Vermont, Georgia, and Puerto Rico, representing a range of hydrologic and climatic conditions, are providing a focal point for research into processes that control the exchange of water, energy, and carbon between the atmosphere and the land surface. Understanding these processes is critical to such important environmental policy issues as greenhouse gases, atmospheric deposition, nutrient enrichment, and biodiversity. A watershed modeling effort that has been started at all sites is expected to lead to a better understanding of the chemical and hydrologic processes in the watersheds and to lead to approaches for scaling up to larger watersheds. Such efforts are critical to understanding how better to manage the Nation's waters.

- Basins and watersheds, where interactions occur among a variety of processes associated with carbon budgets, nutrient transport, land-water interactions, atmospheric chemistry, botany, and geochemistry -- Lake studies, which examine how lakes integrate these and other hydrologic processes and preserve a record of past environmental change in their sediments, are centered on two lake watersheds in Minnesota: Williams Lake and Shingobee Lake. In addition, a Mississippi River basin study is examining nutrient, carbon, and sediment storage in lakes, reservoirs, and wetlands. This study will lead to a better understanding of how changes in land use affect erosion and sedimentation, and the consequences of these changes on the global carbon cycle.

Tools and Methods -- Studies of water resources require the development and enhancement of new tools and methods such as:

- Developing new and refined hydrologic computer models that are used throughout the world, and enhancing existing models by making them more flexible and user friendly. Currently, an increased emphasis is being given to models that are directed towards improving estimates of parameter uncertainty, adding model components that describe microbiological reactions, and coupling water movement, chemical transport, and geochemical reactions.

- Developing and refining methods for determining the age of relatively recent ground water in order to identify and trace the movement of recently recharged ground water. These techniques help delineate source-water protection areas and predict future improvement or degradation of ground water resources.

- Refining methods used in determining the nature of dissolved organic matter so that the techniques can be applied to assessing the potential risks of using reclaimed wastewater to recharge potable-water aquifers.

- Developing a database of nutrient concentrations by compiling water quality data from estuaries around the U.S. and other countries. The database is expected to be used to assess the global status of nutrients in nearshore coastal ecosystems and to compare the susceptibility of different coastal ecosystems to the harmful effects of nutrient enrichment.

Recent Accomplishments

Nutrients Index for Estuaries -- The development of large phytoplankton blooms in estuaries is generally blamed on excessive input of nutrients from human activities, but this does not explain why nutrient-rich San Francisco Bay does not exhibit the same symptoms of eutrophication as the Chesapeake Bay. USGS scientists have developed an index that can be used to determine whether light or nutrient input will be the limiting factor for phytoplankton growth rate in a particular estuary. This index can be used as an objective basis for determining the susceptibility of aquatic ecosystems to the harmful effects of nutrient enrichment and for comparing the potential for harmful-bloom development among ecosystems.

Permeable Reactive Barriers -- At Fry Canyon, Utah, a USEPA Superfund site, the use of permeable reactive chemical barriers (PRB) to control uranium concentrations in contaminated ground water has been tested in collaboration with DOE, BLM, and USEPA. Although tests are continuing, the data show that after 1.5 years, uranium concentrations in the water have been decreased 70-95 percent, depending upon the type of PRB used.

Iron Toxicity in Keswick Reservoir -- Acid mine drainage from the Iron Mountain Superfund site in California has resulted in the accumulation of metal-rich sediments in the Sacramento River's Keswick Reservoir. In cooperative studies with USEPA and BOR, the sediments and their pore waters were analyzed and, via a USEPA contract with Pacific Eco-Risk Laboratories, used in toxicity tests. Results from this cooperative study indicate that iron appears to be the main toxic constituent for aquatic life, rather than copper or zinc as had been previously

assumed. This finding may have a major impact on regulatory requirements for the safety of aquatic life since iron is not currently a regulated element.

Sediment Contamination in San Francisco Bay -- In a special issue of the journal *Marine Chemistry*, published in February 1999, USGS and university scientists documented the impact of human activities on sediment contamination in the San Francisco Bay. This interdisciplinary study was jointly funded by the USGS and NOAA, and was based on analysis of sediment cores from the Bay. The findings indicate that a large estuary contaminated by human activities can take decades to recover even if sources of contamination have been eliminated, but also illustrate the effectiveness of regulation, documenting the decline in concentration of some regulated contaminants despite continued economic growth.